ATMOSPHERE AND SURFACE IMPACTS BY AURORAL ENERGETIC ELECTRON PRECIPITATION (EEP)

PECK ET AL. 2016, *IN PREP*

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OUTLINE

- Energetic Electron Precipitation (EEP)
- Question & Motivation
- Whole Atmosphere Community Climate Model (WACCM)
- Results
- Conclusions

EEP Impacts on Atmosphere

Energetic Electron Precipitation (EEP)

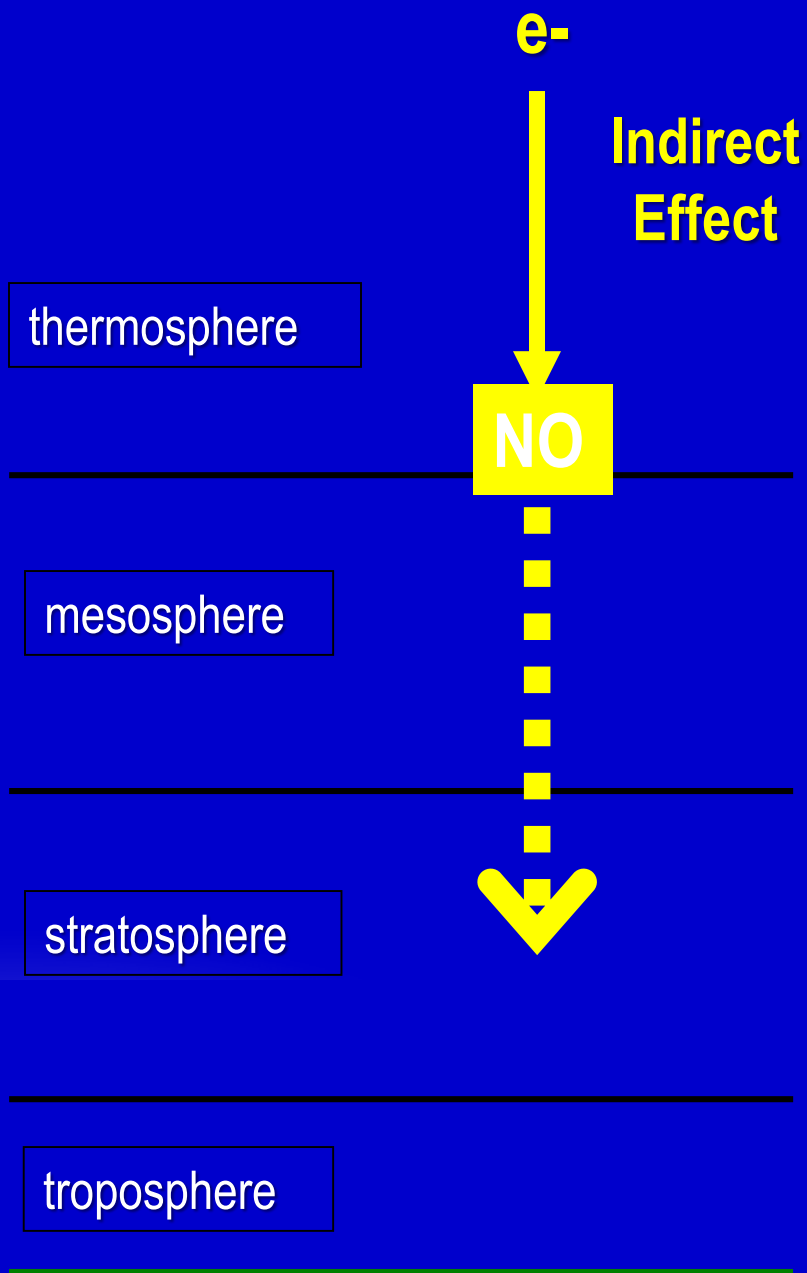
↓ ↓ ↓

Ionization & Dissociation

↓ ↓ ↓

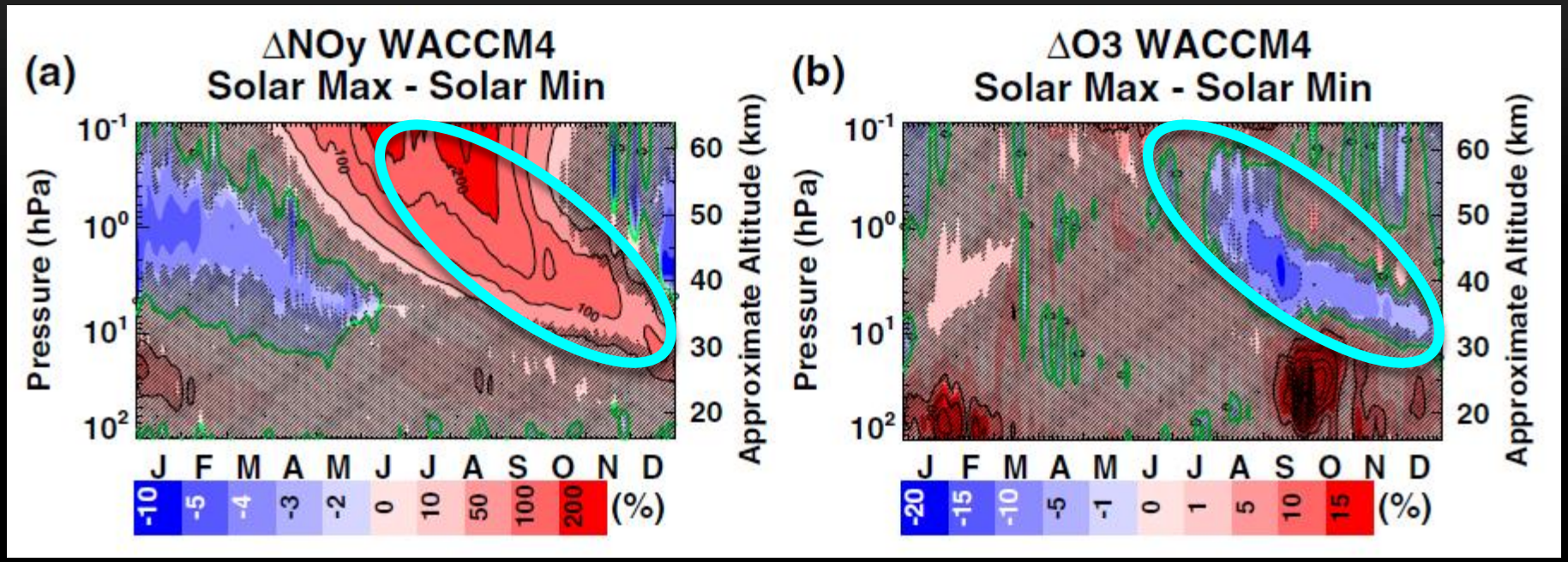
$NO_x = NO + NO_2$

Slide courtesy of Cora E. Randall



What are the atmosphere and surface impacts of auroral EEP?

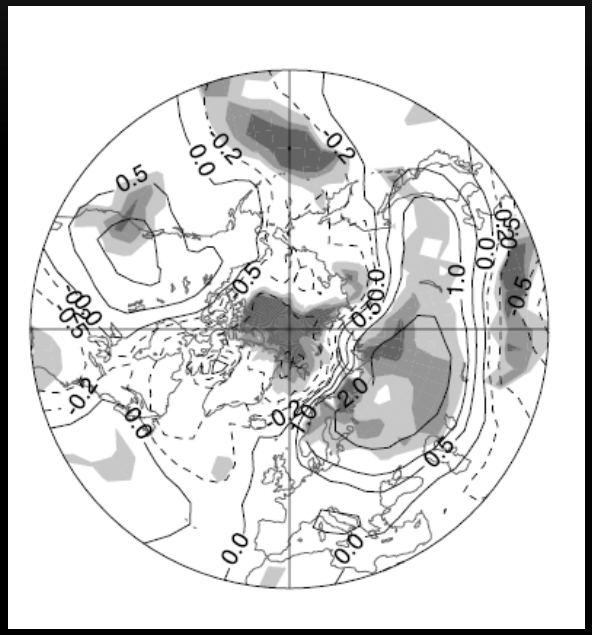
KNOWN EEP IMPACTS IN WACCM4 (CESM 1.0.4)



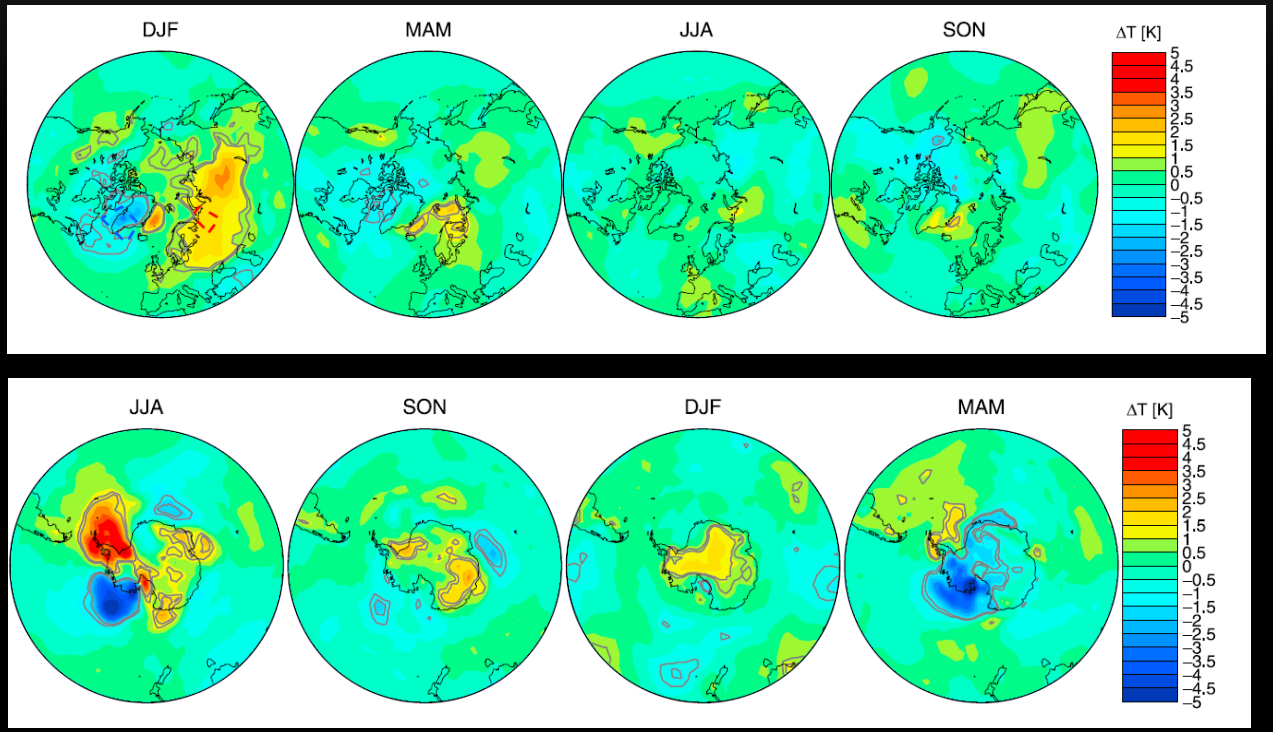
Change with and without auroral EEP in WACCM (*Peck et al.* 2015).

$$NO_y = NO + NO_2 + NO_3 + N_2O_5 + HNO_3 + HO_2NO_2 + ClONO_2$$

STUDIES OF EEP AT THE SURFACE



Surface temperature change using a model with versus without auroral EEP. (*Rozanov et al.* 2005)



Surface Temperature changes in ERA-40 from High Ap – Low Ap years. (*Seppälä et al.* 2009)

THIS IS WHAT WE DO DIFFERENT

1) Isolate EEP from solar spectral irradiance changes.

2) Use coupled ocean model, allowing us to study the troposphere and surface.

3) Kill noise with a long (300 years) integration.

MODEL SPECIFICATIONS

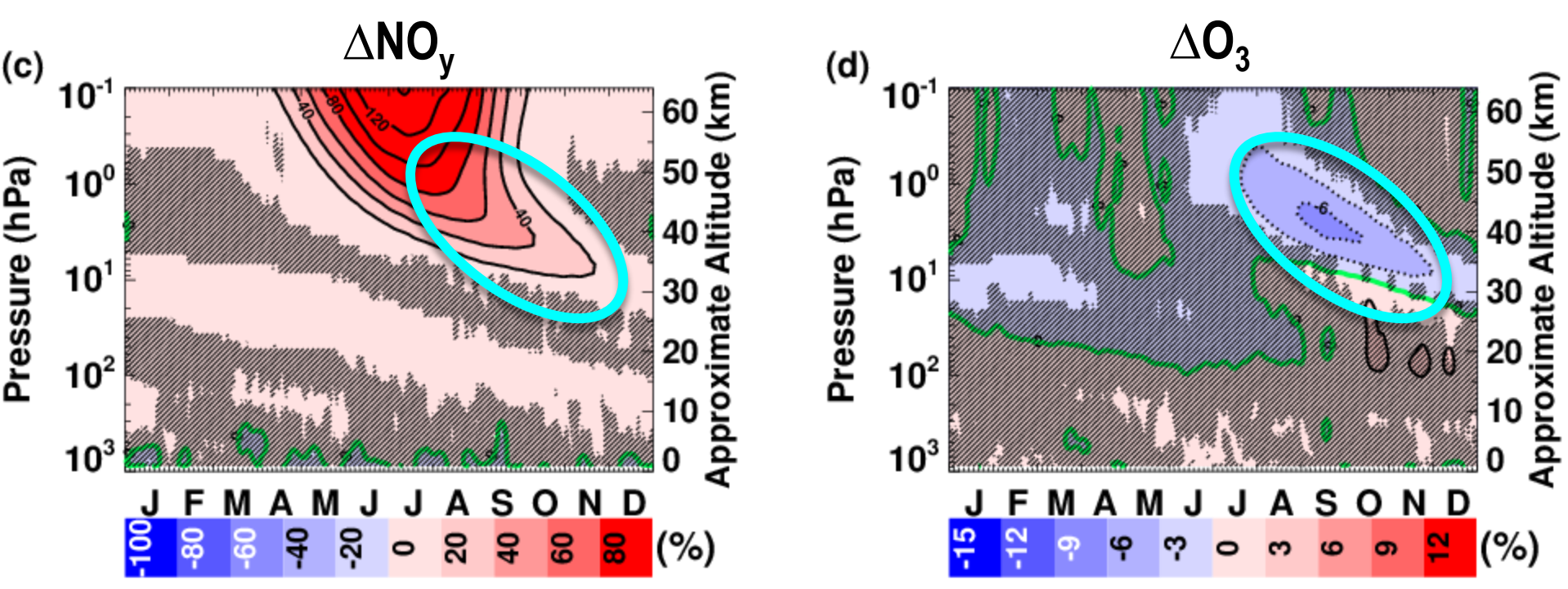
- Community Earth System Model version 1.2.2 (CESM)
- Whole Atmosphere Community Climate Model version 4 (WACCM4)
- Parallel Ocean Program version 2 (POP2)
- 1.9° x 2.5° Horizontal Grid
- 66 vertical levels from surface to ~140 km
- Vertical resolution of ~1.75 km in stratosphere.

TWO SIMULATIONS ARE USED

Name	Run Length (spinup)	Solar Flux (f10.7)	Ap Index
Low EEP	300 years (10 years)	128	3
High EEP	300 years (10 years)	128	27

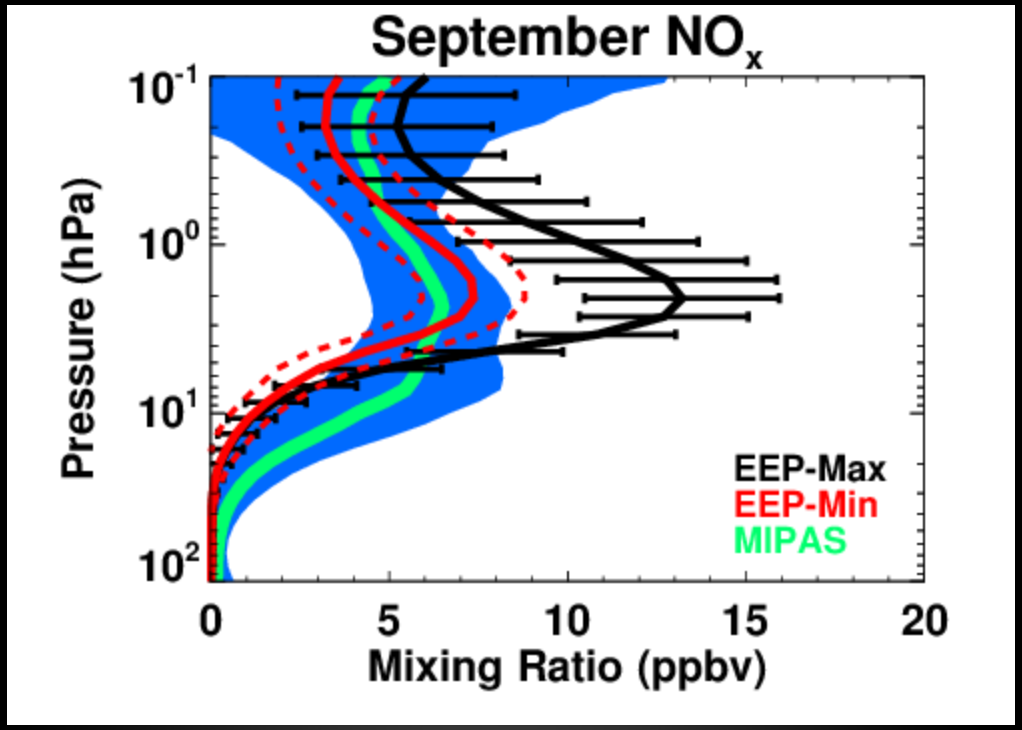
- All plots are differences between the two simulations (High – Low).
- Statistical significance at 95% using the Student's T-test.

STRATOSPHERIC CHEMICAL SPECIES IN AGREEMENT WITH OTHER STUDIES

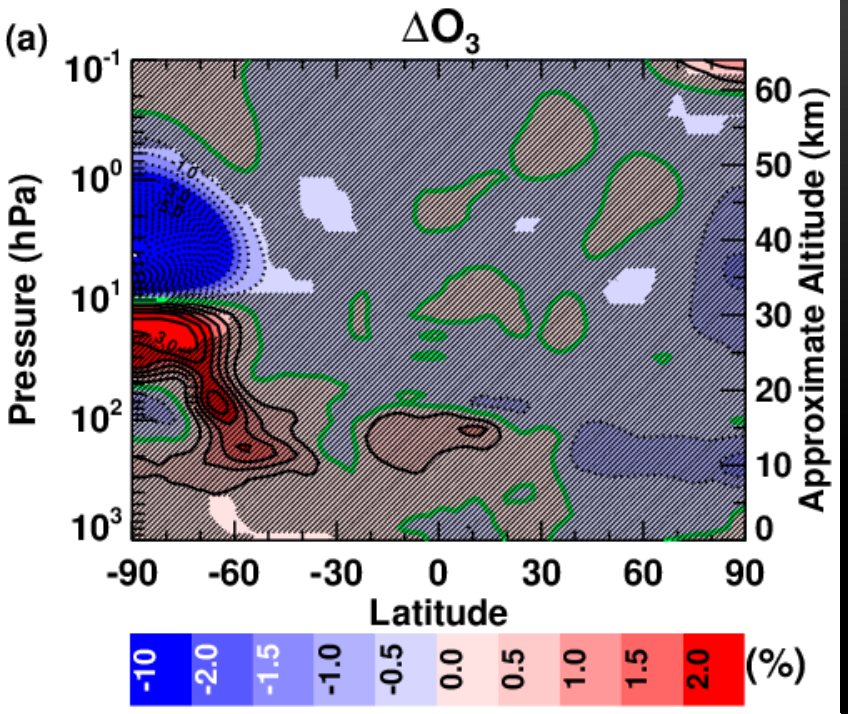


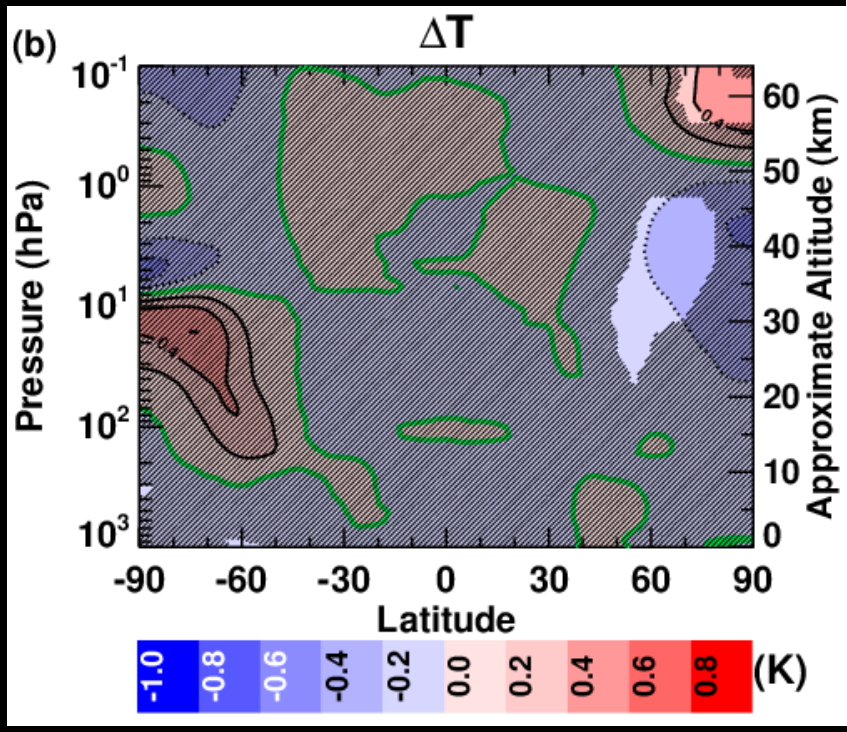
Plots are polar cap averages from geographic 60° to 90°S.

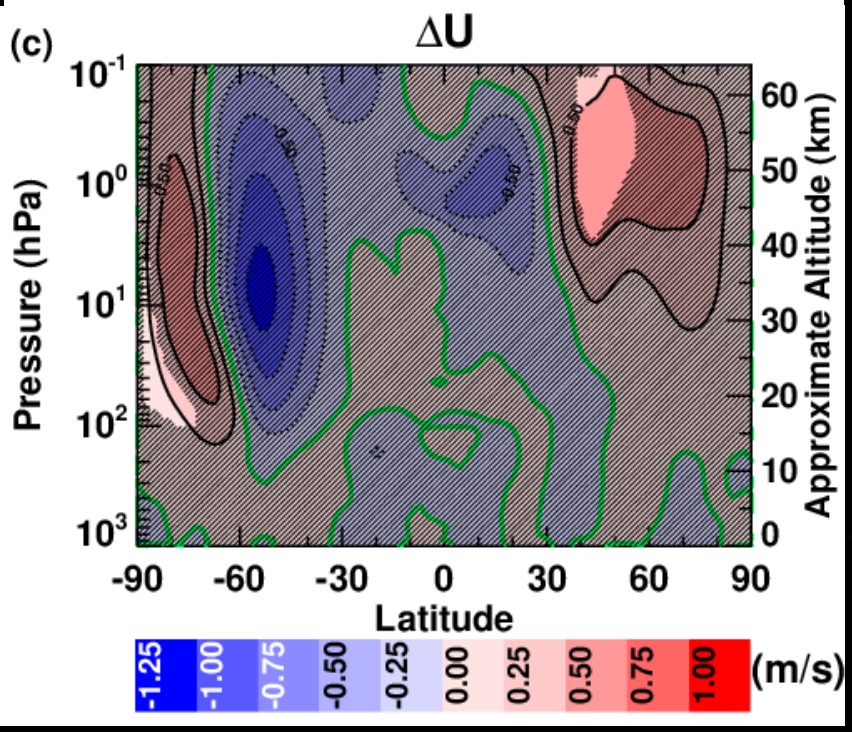
NOX DESCENT IS DECENT



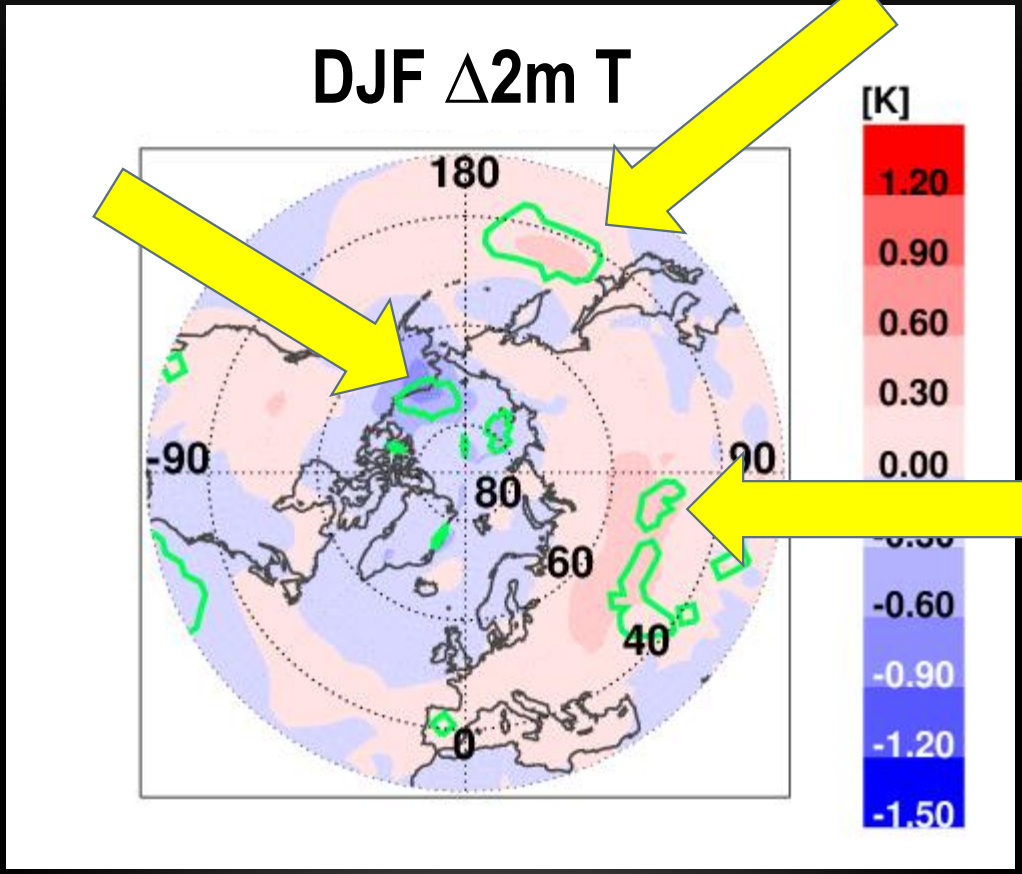
OZONE CHANGE LOOKS *IMPRESSIVE*, BUT DOES IT CHANGE LOCAL DYNAMICS?



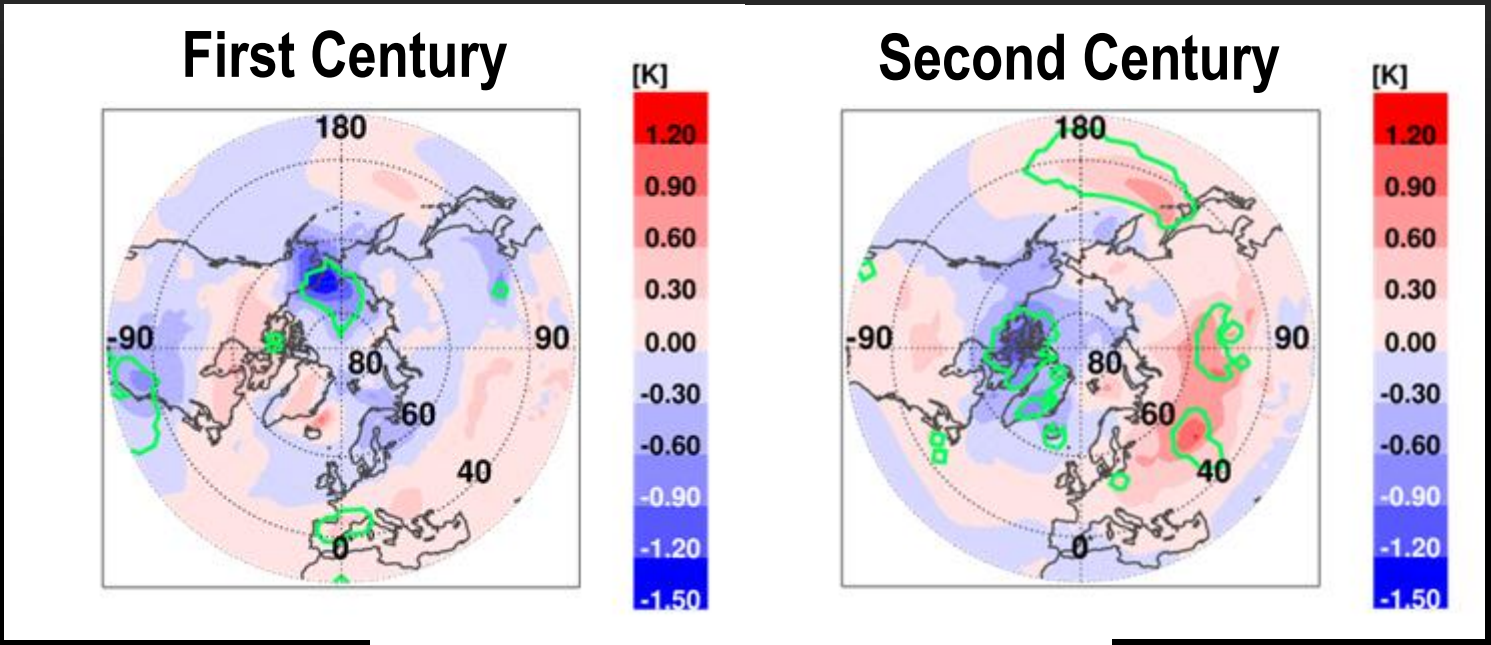




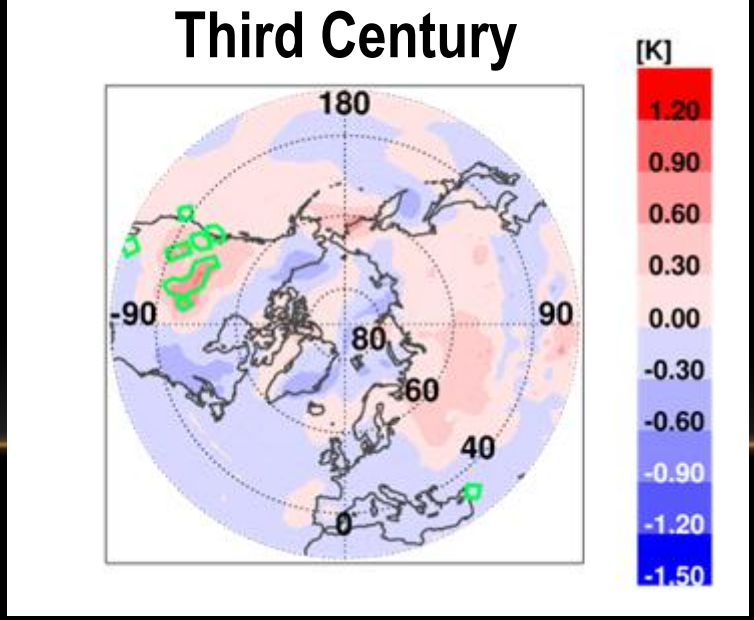
THERE ARE SOME SURFACE IMPACTS



…OR ARE THERE?

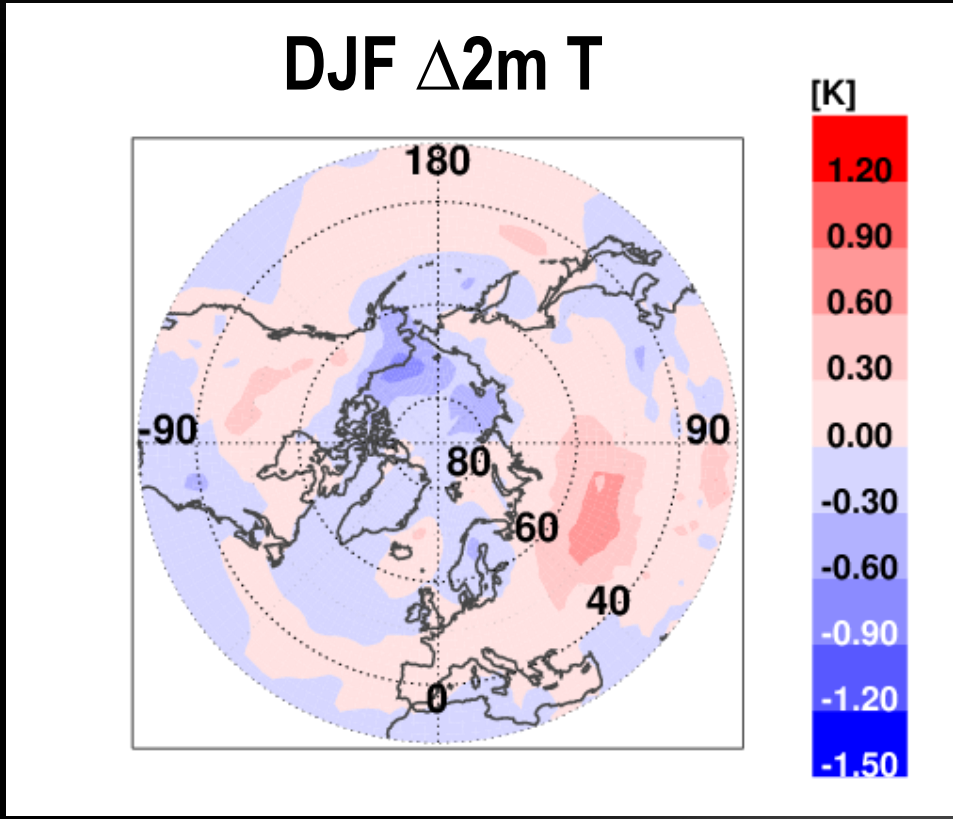


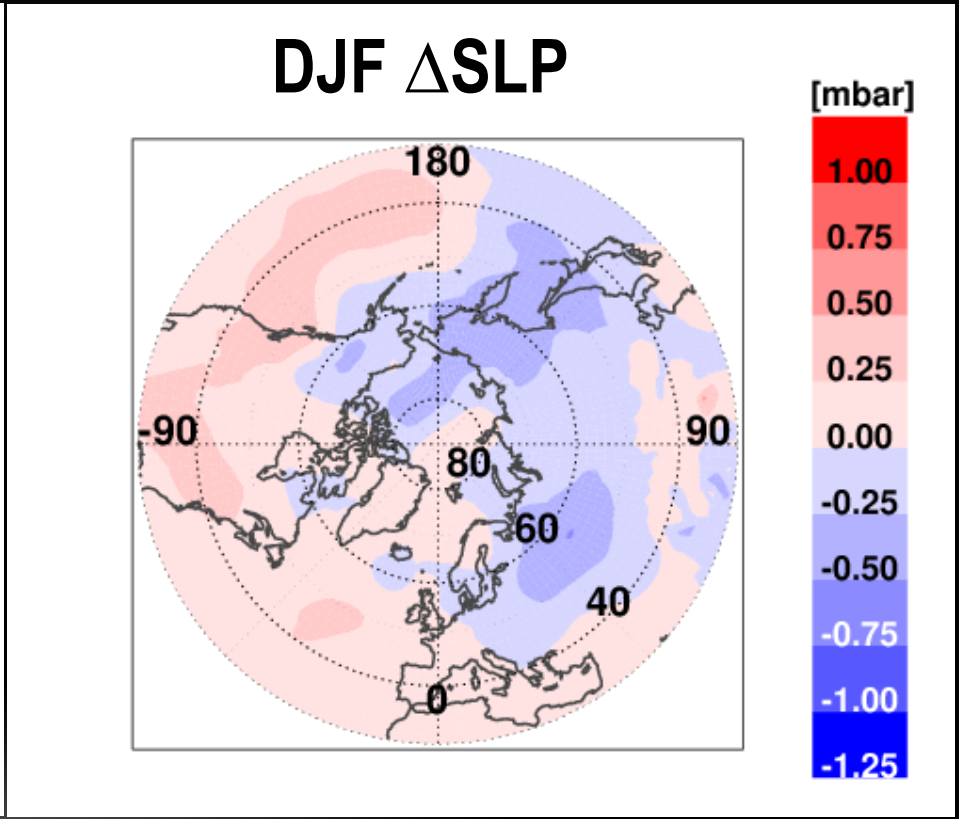
All three plots are DJF ∆2m T.



BOOTSTRAP RESULTS

1 million bootstraps of 10 years.





CONCLUSIONS

- Stratospheric signal in O_3 and NO_y are large, robust, and confirm previous findings.
- Stratospheric dynamics don't change much from O_3 loss caused by auroral EEP generated NO_x.
- Surface signal is not robust.
  - Signal is miniscule, even with long simulations.
  - More thorough statistical analysis reveals no significance.
  - Auroral EEP surface signal may be heavily confounded by internal variability.

WHERE DOES THIS LEAD?

- Continue investigations into “interesting” EEP impacts.
  - Middle and upper atmosphere changes
- Examine possible mechanisms that could tie the stratosphere to the troposphere (e.g., events).

THANK YOU!